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Laser assisted flow deposition: a new method to grow ZnO

J. Rodrigues, M. R. N. Soares, A. J. S. Fernandes, T. Monteiro and F. M. Costa

Department of Physics, Laboratory I3N, University of Aveiro, Campus Universitário de Santiago, 3810-193 Aveiro, Portugal

Zinc oxide (ZnO) has been one of the most studied materials in the last decades. Either as bulk material, epilayers or nanostructures, this direct wide band gap semiconductor is known to possess great potential for fundamental science and modern technology applications.

In the present work, nano and micro crystals of ZnO were grown by the *laser assisted flow deposition* method at atmospheric pressure. In this new process, laser radiation impinges on the top of an extruded rod precursor, producing ZnO crystals by a vapour/solid (VS) mechanism. This method has proved to be very efficient, allowing high yield ZnO deposits at high growth rates applicable to large-scale substrates [1]. ZnO structures were grown with and without the presence of silver under a power laser of 35 W during 3 minutes.

ZnO microcrystals start developing at the top of the precursor rod with a needle-like morphology, Figure 1. In this region, crystallites grow in a branching configuration from a central trunk. A secondary nucleation is observed from the termination of these needles as silver amount increases on the precursor rod. The re-nucleation and sequential growth of crystals lead to a complex three-dimensional ZnO hierarchical architecture. The silver droplets are responsible for the re-nucleation process since they act as a catalyst for the ZnO growth [2].

At the silicon substrate placed 6 mm away from the top of precursor rod, several ZnO morphologies are observed: platelets resulting from bidimensional growth after needle coalescence; needles irradiating from the platelets and tetrapods, Figure 2. Among all structures tetrapods are the most frequent.

X-ray diffraction spectra of the undoped sample and a representative one from 1%Ag doped sample clearly evidence the signature of ZnO crystals together with metallic silver. The high crystalline quality of the ZnO is inferred from the narrow FWHM of the peaks corresponding to the ZnO wurtzite. The high crystalline quality has been corroborated by photoluminescence spectroscopy in a previous work [1].

References

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2. Zhang Z. *et al.*, J. Phys. Chem. C: 111: 17500-17505, 2007

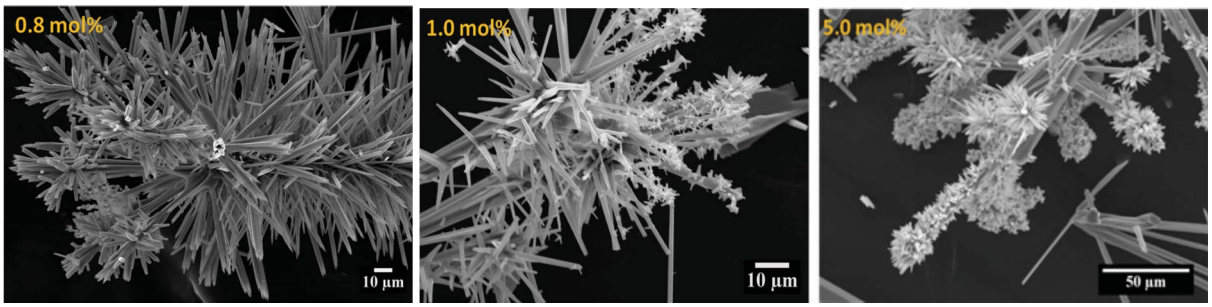

Figure 1. Scanning micrographs of Ag-doped ZnO structures grown on the top of the precursor rod.

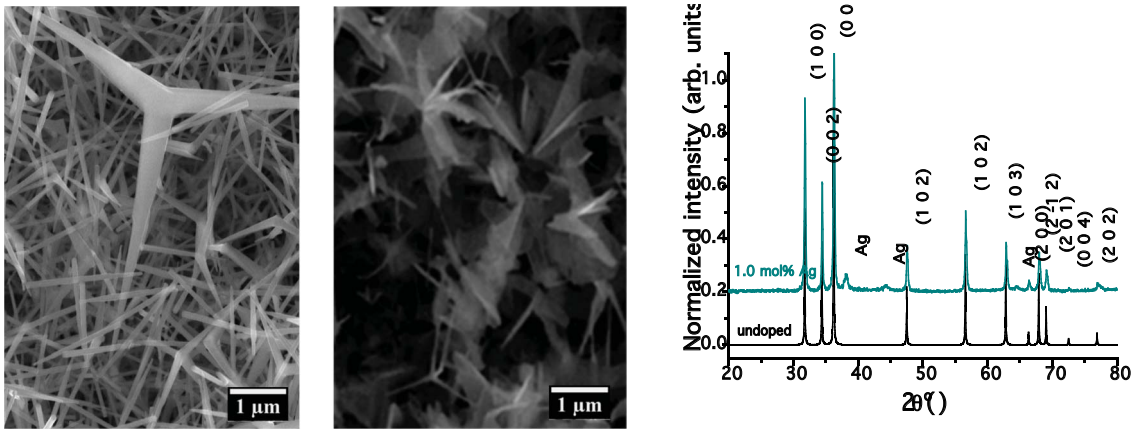

Figure 2. Scanning micrographs of Ag-doped ZnO structures grown on the silicon substrate surface and X-ray diffraction spectra of the undoped and 1%Ag doped ZnO structures.